

CONCLUDING REMARKS FOR ECRIS'02

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1 INTRODUCTION

ECRIS'02 was held in Jyväskylä Finland at the edge of Lake Jyväskylä, which was beautiful location to meet and discuss the state of Electron Cyclotron Resonance ion sources. It was the 15th ECR Ion Source Workshop in a series stretching back to the first workshop held November 6, 1978 in Karlsruhe Germany. Overall, the workshop reports could be characterized as showing solid achievements and steady progress without any spectacular breakthroughs or highly controversial new ideas. In this short report, I will mention some of the highlights and surprises of the workshop that I observed during the meeting and reported on at the close of the meeting. As such, it will be relatively brief and not meant to be all encompassing. Below is a short list of items that made this workshop memorable.

Table 1: Claude's Top 7

7. Toughest schedule On Thursday, five consecutive theory talks were scheduled immediately after a big lunch at the Hotel Alba. It was a severe test for jet lagged participants in a land where the sun sets at 11 PM and rises at 2 AM
6. Best website for an ECRIS Workshop Great links for travel, hotels and preparation of the papers.
5. Farthest north ECRIS Workshop At latitude 62.5 degrees north, it eclipsed the former record of 53 degrees north held by Groningen. College Station Texas holds the southern most latitude of 30 degrees north.
4. Construction of a weaker sextupole Sandor Biri showed the design of a weaker sextupole for their source. Their users want to produce clusters and therefore need colder plasma.
3. Most delayed suitcases Several of us had our suitcases arrive a few days late. The "Finnish" explanation was that a certain Swedish airline was at fault.
2. Most surprising plans The ISN Grenoble group announced plans to reach 1.9 T with a permanent magnet sextupole
1. Best story Geller's explained that he invented ECR ion sources after falling off a ladder while trying to repair a Penning ion source in 1954.

2 OVERVIEW

Arne Drentje opened the workshop with a special session titled "30 years of high charged ECRIS" in which Dr. Richard Geller gave his farewell speech. In his talk, Geller traced the origins of ECR ion sources from his first low charge state ECR developed in 1965 to the present day where an ECRIS is at the heart of the heavy-ion research at CERN and new ECRIS's are being developed for the future heavy-ion program at the LHC. Geller told how at various stages he had been lucky. For example, early in his career he worked with Penning sources and it was their undesirable characteristics that inspired him to seek a better solution. Later at Grenoble, he was able to convert a plasma fusion magnet, CIRCE, into the first high charge state ECR ion source, SUPERMAFIOS. This huge source consumed 3.5 MW of electric power and on at least one occasion its operation caused the lights in Grenoble to dim. As luck would have it, the laboratory management then cut off the power for this project. Geller was then inspired to design and build a compact ECR with a permanent magnet sextupole, which was the first practical ECRIS. While Geller described himself as lucky, these stories demonstrate that he is a physicist who makes his own luck.

One of the trends evident at the workshop is the steady increase in the number of high frequency ion sources. There are many sources operating at 14 GHz, and the number of 18 GHz sources continues to increase. Impressive results in terms of oxygen and argon intensities were presented for two new 18 GHz ECRIS, the Grenoble Test Source (GTS) and PECRIS V from Münster. The PECRIS V uses a plateau field with two microwave frequencies, one at the ECR resonance value on axis and on at a slightly higher frequency. Two sources have operated at 28 GHz, SERSE in Catania and PHOENIX in Grenoble. Both of these sources have used the same gyrotron for microwave power. The highest frequency source, SMIS, in Nizhny Novgorod operates at 37 GHz, although in a somewhat unconventional way with pulse solenoid fields and no sextupole. The scaling experiments done on SERSE at 18 and 28 GHz give added experimental support to Geller's prediction that the plasma density and intensity should scale as the second power of frequency. While the issues around scaling with frequency and magnetic field are largely settled, discussions about scaling performance with length continue, perhaps because it is experimentally difficult to demonstrate.

The technical and financial challenges of building magnets with optimum magnetic fields for 28 GHz and

beyond are significant and this limits the number of projects underway or in the proposal stage. The VENUS ECRIS at Berkeley has sufficient magnetic field for operation at 28 GHz and has produced its first plasma at 18 GHz. Operation at 28 GHz is expected in a year. Santo Gammino reported on the design and funding prospects for Gyro-SERSE, which could operate up to 35 GHz. Zhao described the progress on the design of a superconducting ECRIS called SECRAI planned for the Lanzhou facility and Nakagawa described RIKEN's need for a superconducting, high frequency ECRIS by 2006.

The workshop included a number of talks on production of beams from solid feeds. Since the elements of the periodic table have a wide range of physical and chemical properties, no single method is optimum for all beams. Ovens, MIVOC, sputtering and direct insertion continue to be developed and refined. Muramatsu and Kitigawa reported on the first use of electron bombardment heating for producing beams from solids. This is a promising technique, because very small samples could be used and very high temperatures achieved. Gammino described work to combine laser ion production with an ECR ion source.

CONCLUSION

There was a wide range of participants at the workshop. In addition to some of the pioneers in the field such as Richard Geller, Klaus Wieseman and Arne Drentje, there were many students and young physicists in attendance. As always at these workshops, the enthusiasm was palpable and the physics and development of ECRIS continues to fascinate. We look forward to the next ECRIS workshop, which is scheduled for 2004 in Berkeley California.